A Methodology for Assessment of Spatial Distribution of Flood Risk(Digest_要約)

AUTHOR(S):

Jiang, Xinyu

A Methodology for Assessment of Spatial Distribution of Flood Risk

by
Xinyu Jiang

A thesis submitted as partial fulfillment of requirements
for the degree of
Doctor of Philosophy in Informatics

Graduate School of Informatics
Kyoto university
2014

Chairperson of Supervisory Committee**:**
Professor Hirokazu Tatano
Graduate School of Informatics, Department of Social Informatics

Abstract

Because of many reasons, flood risk management should become more integrated to deal with different types of countermeasures, multiple stakeholders and authorities. To provide scientific platform to assess present situation in a target river basin and to evaluate effectiveness of the integrated countermeasures, it is needed to know the flood risk distribution over the space in the basin.

Spatial flood risk assessment for basin area face challenge that how to assess flood risk from multiple sources. For a place in a river basin, it may be jointly affected by multiple flood sources: flood from a large river, flood from small rivers, inundation due to local rainfall. If the joint effects are ignored, it may lead to the flood risk in this place to be misestimated. The traditional method of flood risk assessment for the purpose of river management is mainly focus on flood risk of one river and one rainfall pattern is specified to conduct spatial flood risk assessment even when multiple flood sources are considered. The research objective of this study is developing a methodology for assessment of spatial distribution of flood risk considering multiple flood risk sources.

Comparing with the traditional flood risk assessment procedures, our proposed methodology emphasize on two key points: (1) estimation of the joint probability of occurrence of flood from multiple sources; (2) requirement of integrated simulation of process from multiple sources to inundated water depth.

For the first point, a copula based method is introduced to estimate the joint probability of occurrence of flood from multiple sources. Copulas are functions that join or “couple” multivariate distribution functions to their one-dimensional marginal distribution functions. Copula offers a way to scale-freely measure dependence as well as construct families of joint distribution. In the assessment of flood risk from multiple sources, occurrence of flood from single source could be treated as marginal distributions, through copula method, the joint probability of occurrence of flood from multiple sources could be achieved.

For the second point, an integrated rainfall-runoff-inundation model is developed for integrated simulation of process from multiple sources to inundated water depth. It is a Geographic information system (GIS) based visualized, simplified rainfall-runoff-inundation model. The hydrological analysis and spatial analysis of Geographic information system (GIS) provide basic data base and kinematic wave equations and simplified shallow water equations constitute the calculation framework. Runoff area is divided by hydrological analysis and a

kinematic wave equation is adopted according to sub basin and counter line based mesh. Inundation area is simulated by a simplified shallow water equations based 2D model. The integration of runoff and inundation is controlled by joining of runoff mesh and inundation mesh, and time steps are coordinated by interpolation. The model makes it possible to simulate runoff, flood and inundation together.

The flood risk assessment is realized through a Monte Carlo method. Through copula method, the joint probability of occurrence of flood from multiple resources can be analyzed and simulated. Given a return period, random rainfall event can be generated. For each of these generated rainfall events, the integrated rainfall-runoff-inundation model is used to simulate the inundation water depth over the risk assessment area and the corresponding loss could be calculated. The risk at each place is represented by probability distribution of loss.

The methodology was applied to Otsu river basin, Osaka, Japan. The case study demonstrate the feasibility of methodology proposed in my research and show the significance of flood risk assessment considering multiple sources.